

DRAWINGS ATTACHED.

Inventor:—RALPH SPENSER HOOPER.*Date of filing Complete Specification*: Feb. 4, 1959.*Application Date*: June 2, 1958. No. 17600/58.*Complete Specification Published*: Feb. 22, 1961.

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COMPLETE SPECIFICATION.

Improvements in Aircraft.

We, HAWKER AIRCRAFT LIMITED, a British Company, of Richmond Road, Kingston-upon-Thames, in the County of Surrey, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to aircraft of the fixed wing type propelled by means of one or more gas turbines.

Although applicable to commercial aircraft, the invention is particularly concerned with high speed service aircraft having comparatively high wing loadings.

Such aircraft are often required to operate from comparatively short landing strips or small aerodromes or from aerodromes situated at high altitudes or, in the case of carrier-borne aircraft, have to operate from the comparatively short deck of an aircraft carrier, and consequently the problem with which the aircraft designer is confronted is to design an aircraft which will fulfil the requirements as regards speed, rate of climb, etc., and at the same time shall be capable of taking off and landing in the space available. Auxiliary braking devices, such as braking parachutes, are now commonly used to reduce the length of the landing run, but to decrease the take-off run it is necessary to employ either auxiliary rocket motors, or in the case of carrier-borne aircraft, a steam or other type of catapult.

The chief object of the present invention is to evolve an aircraft propelled by a gas turbine wherein the whole of the available thrust can be directed rearwardly for forward propulsion or downwardly to produce upward lift with or without forward motion.

A further object of the invention is to so arrange the gas turbine on the aircraft that when used for vertical take off and landing the downward thrust available will be balanced fore and aft of the centre of gravity of the aircraft, the centres of thrust being situated fairly close to the centre of gravity to maintain the length of the moment arm at a minimum.

The gas turbine employed in carrying out the present invention is of the kind wherein only a part of the compressed air passes to the combustion chambers, the bulk of the air which is compressed being available to produce a downward thrust for vertical take off, forward of the centre of gravity of the aircraft.

An aircraft in accordance with the present invention has a gas turbine mounted within the fuselage at or about the centre of gravity of the aircraft and has associated therewith a pair of nozzles situated forward of the centre of gravity and a second pair of nozzles situated aft of the centre of gravity, the nozzles comprising each pair projecting from the fuselage on opposite sides, the forward pair of nozzles discharging air bled from the compressor of the gas turbine, the aft pair of nozzles discharging efflux gases from the turbine, the nozzles being mounted for simultaneous orientation, whereby the whole volume of air and efflux gases discharged from the four nozzles can be directed rearwardly and used for forward propulsion or directed downwardly to produce vertical lift.

Referring to the accompanying drawings:—

Figure 1 is a fragmentary plan view of an aircraft having a gas turbine and nozzles

arranged in accordance with the invention;

Figure 2 is a side elevation;

Figure 3 is a sectional view looking rearwardly and showing the two forwardly positioned nozzles; and

Figure 4 is a similar view to Figure 3 but showing the two aft nozzles.

The invention is shown applied to a single engine aircraft of the shoulder wing type, the gas turbine indicated generally by reference numeral 1 being mounted within the fuselage 2 at or about the centre of gravity of the aircraft, the approximate position of the centre of gravity being indicated in Figures 1 and 2, the wing of the aircraft being indicated by reference numeral 3.

The compressor casing 4 of the gas turbine has two branch passages 5 leading to two nozzles 6 projecting from the fuselage on opposite sides forward of the centre of gravity of the aircraft and from which air bled from the compressor is discharged. As shown clearly in Figure 2 nozzles 6 are preferably situated on the longitudinal datum line 7 of the aircraft containing the centre of gravity.

The gases from the turbine pass through a short bifurcated jet pipe 8 to two further nozzles 6a through which the products of combustion are discharged.

Nozzles 6 are arranged slightly outboard of nozzles 6a, fairings 9 and 9a being arranged respectively in front of nozzles 6 and 6a for drag reduction during forward flight. The fuselage immediately behind the forward and aft nozzles is formed with rearwardly directed ducts 10 and 10a for guiding the air and exhaust gases rearwardly during forward flight.

In order to turn the issuing air and exhaust gases through an angle of substantially 90° the nozzles are provided with internally positioned spaced guide vanes 11.

Nozzles 6 and 6a are connected with passages 5 and bifurcated jet pipe 8 by annular pipe couplings 12 which permit orientation of the nozzles about their axes through an angle of a little more than 90°, although this angle may be increased if desired to approximately 180° to provide a forwardly directed thrust for braking purposes. Orientation of the four nozzles is simultaneous by suitable operating mechanism under the control of the pilot.

The drawings show by full lines the position of the nozzles for forward propulsion, the position assumed by the nozzles for vertical take off or hovering being indicated by dotted lines in Figures 3 and 4.

To stabilize the aircraft during vertical take off and at other times when the control surfaces are ineffective, downwardly directed control nozzles are provided at or near the nose and tail and at the wing tips and air

is bled to these nozzles from the compressor through branch pipes 13.

To enable sufficient air to be bled from the compressor to the stabilizing nozzles, nozzles 6 are positioned as is shown in Figure 3, whereby parts of nozzles 6 will be blanked off by parts 14 of the fuselage when nozzles 6 are situated in the dotted line position. Any loss in downward thrust from nozzles 6 as a result of such blanking off will be compensated for by the stabilizing effect of the front stabilizing nozzles situated at or near the nose of the aircraft.

The stabilizing control nozzles will be brought into operation at any speed when the flying control surfaces are ineffective and may during a steep angle landing approach be used to maintain the aircraft in an attitude which would enable the pilot to obtain an unrestricted view of the landing area.

As is shown clearly in Figures 1 and 2 the four nozzles 6 and 6a are well spaced from the centre of the wing and are positioned around the periphery of the wing at the root with the object of minimising "ground suction effect" normally present on jet borne vertical take off aircraft when in close proximity to the ground.

The shoulder wing preferably employed has a fairly pronounced anhedral angle whereby the centre of thrust from the four nozzles can be arranged to pass through the centre of drag when in their forward propulsion position.

With the ducted fan or by-pass type turbo-jet unit proposed the entire engine thrust can be used effectively for both forward propulsion and vertical lift.

Furthermore although it is proposed that the nozzles shall be oriented into either of two positions for vertical take off and landing or for forward flight and possibly a third position to provide a braking effect, it is within the scope of the invention to utilize them to give a steep angle of take off or landing approach by directing them both rearwardly and downwardly.

Any suitable means may be used for simultaneously orientating the nozzles such as pneumatic, hydraulic, electric or mechanical means under the control of the pilot and orientation of the nozzles to produce a downward thrust may be arranged to bring the stabilizing nozzles into operation automatically.

WHAT WE CLAIM IS:—

1. An aircraft having a gas turbine mounted within the fuselage at or about the centre of gravity of the aircraft and having associated therewith a pair of nozzles situated forward of the centre of gravity and a second pair of nozzles situated aft of the centre of gravity, the nozzles comprising each

pair projecting from the fuselage on opposite sides, the forward pair of nozzles discharging air bled from the compressor of the gas turbine, the aft pair of nozzles discharging efflux gases from the turbine, the nozzles being mounted for simultaneous orientation, whereby the whole volume of air and efflux gases discharged from the four nozzles can be directed rearwardly and used for forward propulsion or directed downwardly to produce vertical lift.

2. An aircraft having a gas turbine mounted within the fuselage at or about the centre of gravity of the aircraft and having associated therewith a pair of nozzles situated forward of the centre of gravity, the gas turbine having a short bifurcated jet pipe leading to the nozzles of a second pair situated aft of the centre of gravity, the nozzles comprising each pair projecting from the fuselage on opposite sides, the forward and aft pairs of nozzles being disposed at approximately the same distance from the centre of gravity, the forward pair of nozzles discharging air bled from the compressor of the gas turbine, the aft pair of nozzles discharging efflux gases from the turbine, the nozzles being mounted for simultaneous orientation, whereby the whole of the volume of air and efflux gases discharged from the four nozzles can be directed rearwardly and used for forward propulsion or directed downwardly to produce an upward lift with or without forward movement.

3. An aircraft as claimed in Claim 1 or 2, wherein the four nozzles are well spaced from the centre of the wing and positioned around the periphery of the wing for the purpose of minimising ground suction effect during vertical take off or when hovering near the ground.

4. An aircraft as claimed in any of the preceding claims, wherein each nozzle includes a series of spaced guide vanes which are so constructed and arranged as to turn the issuing air or efflux gases through substantially a right angle.

5. An aircraft as claimed in any of the preceding claims, wherein the forward pair of nozzles are arranged slightly outboard of the aft pair of nozzles for the purpose of preventing interference of the free flow of compressed air from the forward pair, by the aft nozzles during forward flight.

6. An aircraft as claimed in any of the preceding claims having valve controlled downwardly directed jet orifices at the wing tips and at or near the nose and tail of the aircraft for stabilising purposes when the normal flying control surfaces are ineffective, the jet orifices being connected with the compressor casing by means of suitable pipes characterised in that means is provided whereby a part of the discharge area of the forward pair of nozzles will be blanked off when said nozzles are orientated into a downwardly directed position and such stabilising means is in operation.

7. An aircraft as claimed in any of the preceding claims and of the shoulder wing type, the wings of the aircraft being set at an anhedral angle, the forward and aft nozzles being so positioned that the thrust line during forward flight passes through or substantially through the centre of drag of the aircraft.

8. An aircraft as claimed in any of the preceding claims, wherein the drag of the forward and aft nozzles is minimised by fairings arranged in front of each nozzle.

9. An aircraft as claimed in Claim 8, wherein the fuselage immediately behind each nozzle is formed with a rearwardly directed duct for guiding the air and efflux gases rearwardly during forward flight.

10. An aircraft as claimed in any of the preceding claims, wherein the nozzles are mounted for orientation through an angle of substantially 90° .

11. An aircraft as claimed in any of Claims 1 to 9, wherein the nozzles are mounted for orientation through an angle of substantially 180° to provide a forward thrust, vertical lift or braking effect as required.

12. An aircraft substantially as hereinbefore described with reference to the accompanying drawings.

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PROVISIONAL SPECIFICATION.

Improvements in Aircraft.

We, HAWKER AIRCRAFT LIMITED, a British Company, of Canbury Park Road, Kingston-upon-Thames, in the County of Surrey, do hereby declare this invention to be described in the following statement:—

This invention relates to aircraft of the fixed wing type propelled by means of one or more gas turbines.

Although applicable to commercial aircraft, the invention is particularly concerned

with high speed service aircraft having comparatively high wing loadings.

Such aircraft are often required to operate from comparatively short landing strips or small aerodromes or from aerodromes situated at high altitudes or, in the case of carrier-borne aircraft, have to operate from the comparatively short deck of an aircraft carrier, and consequently the problem with which the aircraft designer is confronted is to design an aircraft which will fulfil the requirements as regards speed, rate of climb, etc., and at the same time shall be capable of taking off and landing in the space available. Auxiliary braking devices, such as braking parachutes, are now commonly used to reduce the length of the landing run, but to decrease the take-off run it is necessary to employ either auxiliary rocket motors, or in the case of carrier-borne aircraft, a steam or other type of catapult.

The chief object of the present invention is to evolve a construction of aircraft of the above type which will be capable of vertical take-off or of taking off at an abnormally steep angle of ascent and without the assistance of additional thrust-producing devices, such as rocket motors.

A further object is to enable such an aircraft to be landed with a minimum landing run and to render such an aircraft capable of sustained hovering flight.

An aircraft in accordance with the present invention and of the kind set forth, is characterised by the provision of one or more efflux nozzles situated fore and aft of the centre of gravity of the aircraft, the direction of flow of the efflux gases being directionally controllable whereby a balanced or substantially balanced directionally controlled thrust can be obtained fore and aft of the centre of gravity for forward propulsion, or alternatively for vertical take-off or take-off at an abnormally steep angle of ascent.

Although it is within the scope of the invention to employ any suitable form of gas deflectors associated with the efflux nozzles for directing the issuing gases in the desired direction, it is thought to be more practicable to employ a system of simultaneously angularly movable nozzles, the nozzles being shaped so that the direction of the outflowing gases will be at right-angles or substantially at right-angles to the axis about which each nozzle is angularly moved, the turning of the issuing gases through a right-angle being assisted by curved guide vanes mounted in the mouth of each nozzle.

The term "efflux nozzle" is intended to cover a nozzle from which the products of combustion of the gas turbine are discharged or a nozzle from which air compressed by the compressor is discharged, it being preferred in carrying out the invention, to employ a form of ducted fan engine wherein only a

proportion of the compressed air will be passed to the combustion chambers, the remainder or bulk of the air being discharged through the forwardly positioned nozzle or nozzles after compression.

Although it is within the scope of the invention to employ one forwardly positioned and one rearwardly positioned nozzle, it will generally be preferred to employ four nozzles, two nozzles being situated in front of the centre of gravity of the aircraft and two rearwardly thereof, the pairs of forwardly and rearwardly positioned nozzles being situated on opposite sides of the aircraft's longitudinal axis.

In the case of a single-engined aircraft, it is preferred to employ a system of divergent jet pipes leading to nozzles arranged on opposite sides of the fuselage, such an arrangement being disclosed by our prior Patent No. 585,557. Two bifurcated jet pipes are preferably employed, one pair receiving the products of combustion from the turbine casing, the other pair receiving compressed air from the compressor.

It is proposed, therefore, to arrange the gas turbine at or about the centre of gravity of the aircraft, and to arrange the efflux nozzles forward and behind the centre of gravity, the fore-and-aft efflux nozzles being disposed as near as possible to the centre of gravity so as to maintain the moment arm of each thrust component as short as possible.

It is preferred that the nozzles shall be capable of angular movement through 180° so that although normally the issuing gases will be directed rearwardly for forward propulsion, the nozzles can be turned so that the gases will be directed downwardly, either vertically downwardly or at a suitable angle to the horizontal, or forwardly so that a reverse thrust can be obtained when landing, to effectively reduce the length of the landing run.

Such a construction of nozzle will not protrude to any great extent from the fuselage of the aircraft, but a suitable fairing may be provided in front of each nozzle if required.

It will be necessary in the case of a vertical take-off or for take-off at a comparatively steep angle with a forward speed below stalling speed, to employ an auxiliary control under such take-off conditions, and consequently it is proposed to fit valve controlled jets at the wing tips and also at the nose and tail of the aircraft, through which air bled from the compressor or obtained from an auxiliary compressor can be directed downwardly, as required, to stabilise the aircraft during take-off and before the aircraft has reached a sufficiently high forward speed to enable the normal control surfaces to become effective. Such an auxiliary control would, of course, be used under similar con-

5 ditions as when making a landing below stalling speed or for hovering flight, and during a landing approach could be used to maintain the aircraft in an attitude which would enable the pilot to obtain an unobstructed view of the landing area.

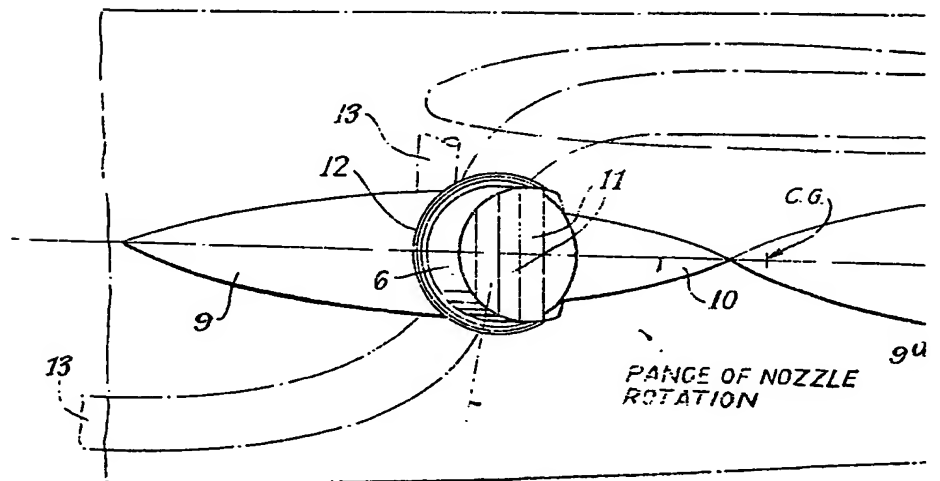
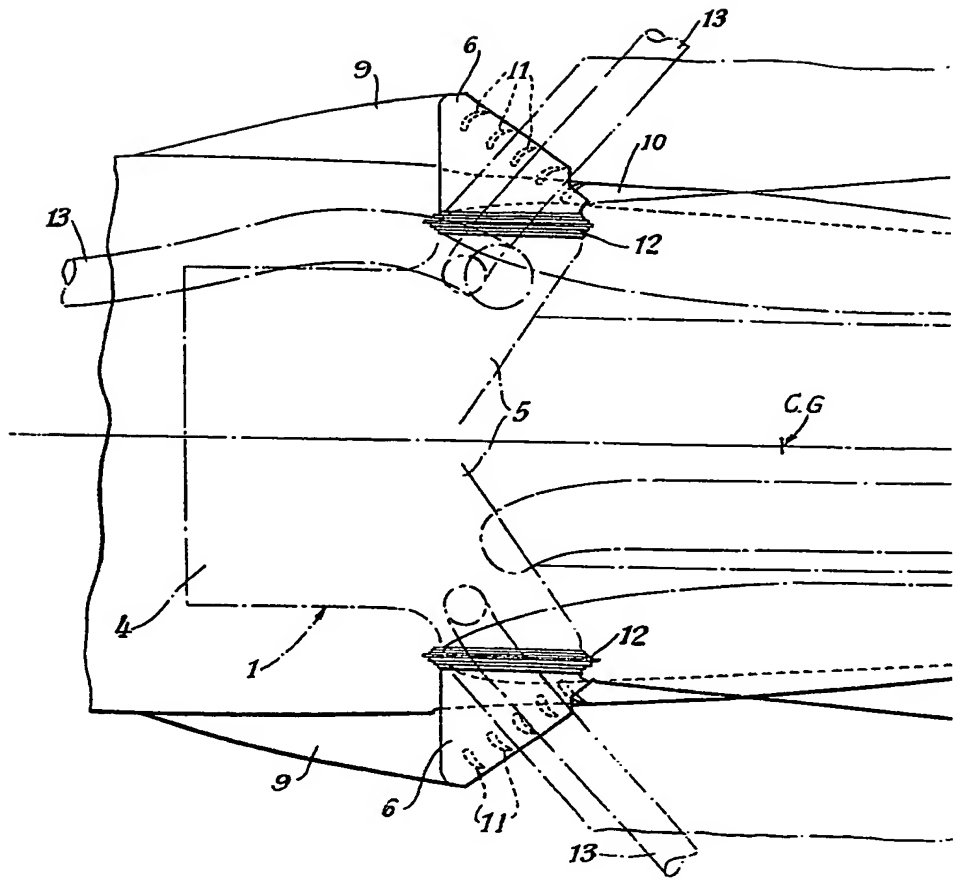
10 Any suitable means may be used for angularly adjusting the nozzles. For example, they may be moved pneumatically, hydraulically, electrically, or mechanically.

In the case of a twin-engined aircraft, the engines are preferably arranged side by side,

the jet pipes from the two engines extending forwardly and rearwardly and outwardly, where they terminate in efflux nozzles at the sides of the fuselage. 15

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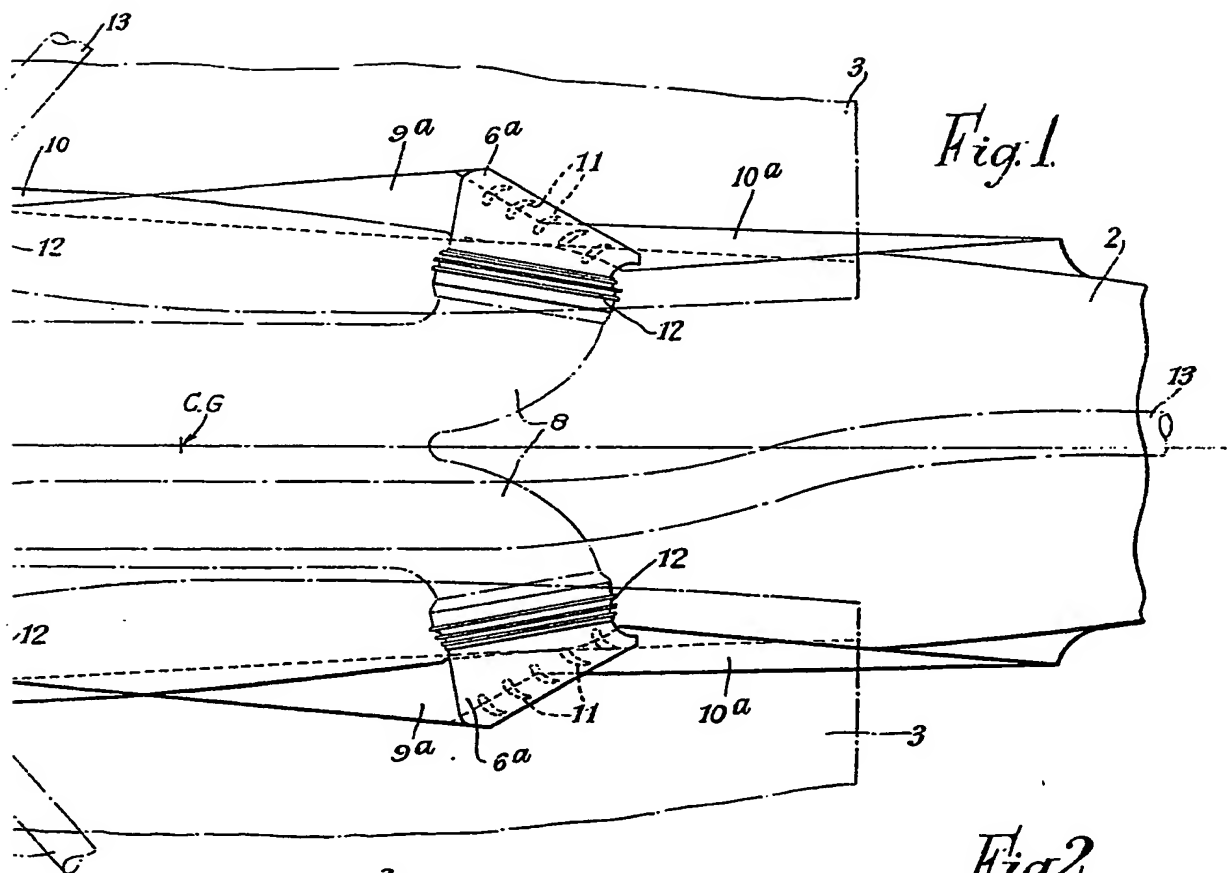


Fig. 1.

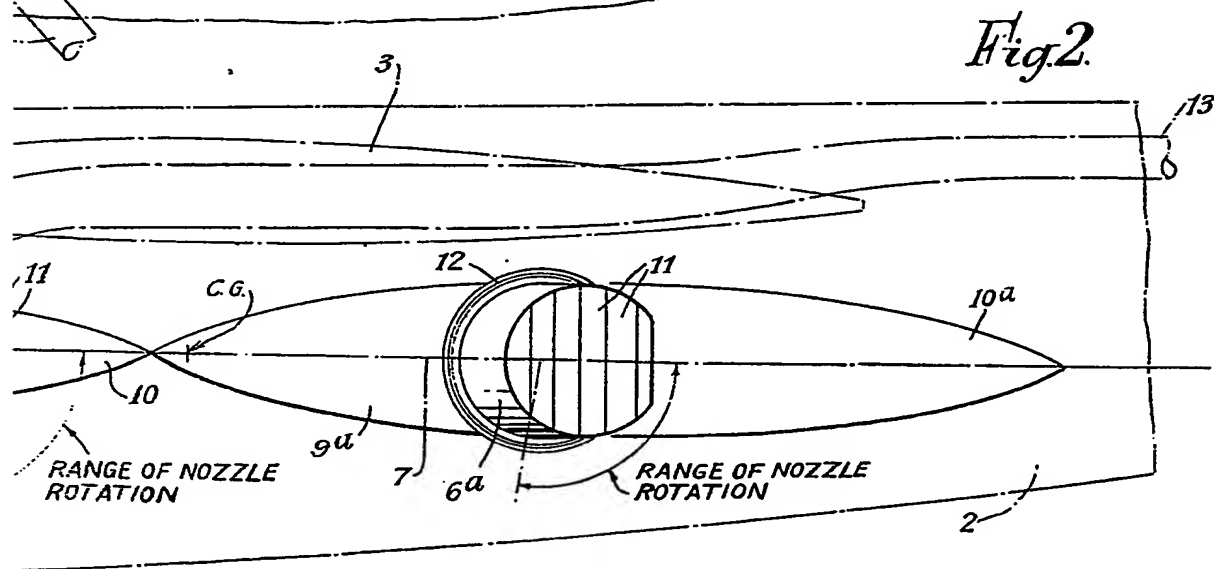
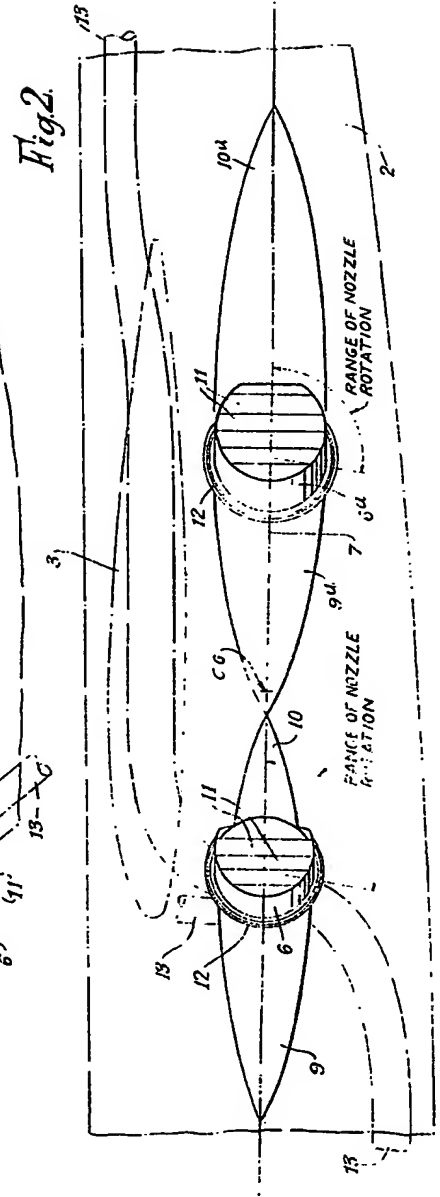
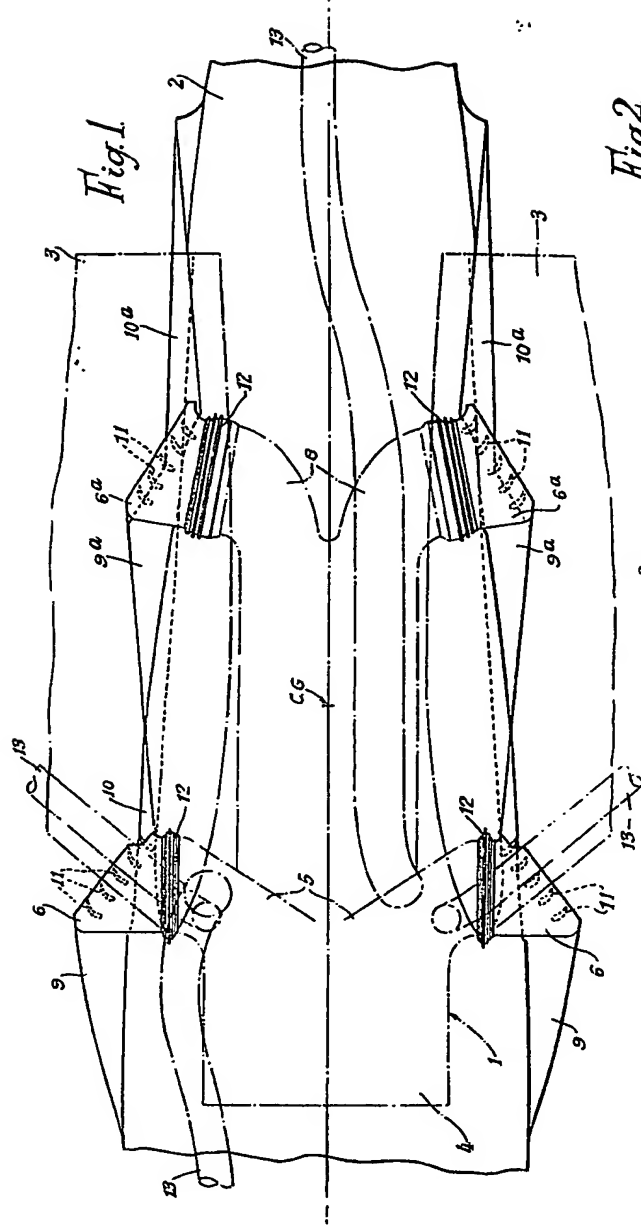


Fig. 2.



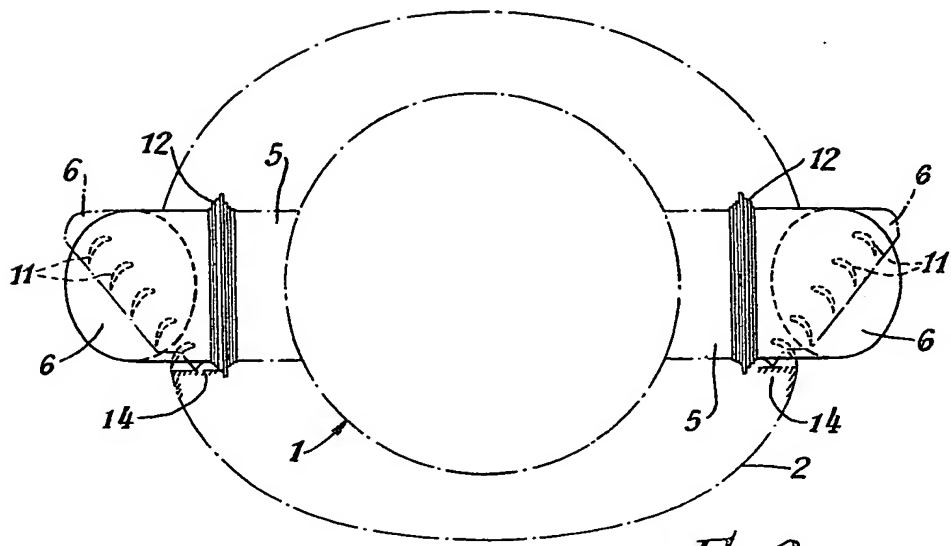


Fig. 3.

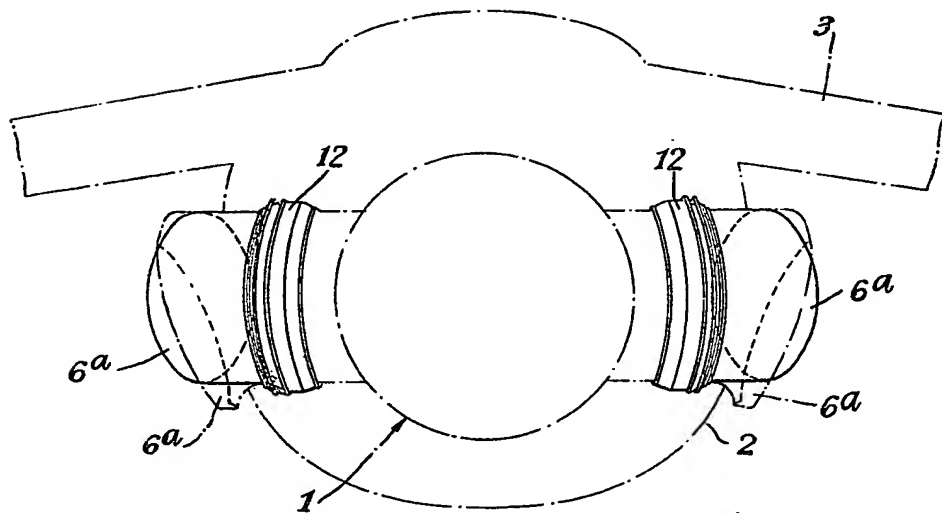


Fig. 4.

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